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A DECENTRALIZED AUTONOMOUS SYSTEM USING A BLOCKCHAIN TECHNIQUES

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ABSTRACT

Ecosystem operated by Centralized ride-sharing system, where customers have limited access to data and information. This creates a lack of transparency and makes it difficult for users to evaluate the quality of the service they receive. These operators charge a commission for their services and increases the fare heavily during peak hours. Such things operate under a set of rules and regulations, which can limit the flexibility of the service. They collect and store a significant amount of user data, including location, payment information, and personal details. Cyber attacks or identity theft by compromise the privacy of the users and make them vulnerable.

As an automated peer-managed version of Ola and Uber, the proposed solution is decentralized application, that utilizes trustless smart contracts. The model eliminates middle-men and projected fare is reduced. This is revolutionary where disputes can be sorted out and moved by trust-less smart contracts with legal liability.

Improved privacy, cost effectiveness and ride fairness of the proposed solutions shown by experimental results.

KEYWORDS: Ride Sharing-Decentralized, Ethereum Blockchain, Smart Contracts

1. INTRODUCTION

The transportation system of every municipality gained by significant importance by Rider-hailing services. Their on-demand availability model allows customers to easily reserve private or shared automobiles, making them more appealing than traditional cabs. The cab service industry in India alone is value dat $10 billion, with a flood of ride-sharing providers in the market. However, most of these systems are centralized and controlled by a third party, raise in concerns about privacy and trust.

Large taxi-hailing companies have dominated the sector, leading to driver exploitation through exorbitant surge fees and profit-maximizing strategies. Many drivers from rural areas have migrated to urban areas in search of better opportunities, but they face immense challenges in meeting their daily expenses, dealing with debts and loans, and achieving weekly and monthly trip objectives. Local taxi drivers have suffered as consumers are attracted to the competitive pricing offered by taxi-hailing companies.

To address these issues, a proposed solution has been presented using Ethereum, a distributed blockchain platform. Ethereum enables the creation and execution of smart

contracts, utilizing the crypto currency Ether (ETH). Angular, a popular JavaScript framework, is used for creating a user-friendly and visually appealing front-end.

Data organization and storage are handled through MongoDB, ensuring encrypted data for website functionality. Ganache, a blockchain emulator, facilitates testing and debugging of Ethereum smartcontracts. Meta masks implifies user communication with Ethereum-based dApps, and Web3.js enables interaction with the Ethereum blockchain.

By leveraging these technologies, the proposed solution aims to build a robust ecosystem with improved user interfaces, secure transactions, and efficient data management for the decentralized application METADRIVE on the Ethereum blockchain.

The objectives are to build up a decentralized system which connects driver and rider directly without intervention of anyone., uses pseudonymity to preserve of anonymity and the unravelling of transactions and also thoroughly ensures ride fairness, payment fairness and user privacy.

The paper consists of the following sections: Literature Review (Section II) provides an overview of existing systems and techniques. Approach (Section III) explains the methodology and system modules. Implementation (Section IV) delves into module interactions. Experiments and Results (Section V) analyze quality assurance measures. Conclusion (Section VI) reflects on the obtained results and Future Scope is discussed. Section VII lists the referenced papers.

2. LITERATURESURVEY

In the pursuit of knowledge and advancement, research plays a pivotal role in uncovering new insights and pushing the boundaries of human understanding.

The domain ventured into had limited scholarly works available. While a few papers were in existence, they were scarce, and

each carried its own set of limitations and drawbacks. However, these initial studies provided valuable groundwork and set the stage for the investigation, offering valuable insights and perspectives that informed subsequent efforts.

[1]Sowmya Kudva proposes a decentralized system called Pebers to track ride at a using blockchain. Smart contracts are explored for creating and managing decentralized ride- hailing capabilities. The trials show that the driver smart contracts used in the system are more cost-effective and profitable for drivers.

This effort aims to enhance transportation in smart cities using blockchain's auditability, anonymity, and immutability. However, the paper overlooks scalability challenges faced by blockchain platforms, leading to slower networks and increased costs as user and transaction numbers grow. It also lacks a detailed analysis of security, specifically vulnerabilities and attacks on the smart contracts used in the ride-hailing process.

In [2], Richard Joseph defines blockchain technology as a decentralized ledger that records all transactions and digital events shared among participating entities. In the context of the ride sharing system Block Wheels, Joseph aims to develop a decentralized application where transactions, fare computation, matching, and data are recorded on a distributed ledger accessible to all network peers. This eliminates the need for intermediaries and enhances transparency and dependability. Blockchain ensures data immutability and is employed to store ride and user information, thus improving privacy and trust in ridesharing. However, the model's lack of compatibility with other cryptocurrencies limits its flexibility, and a more dynamic ride matching algorithm could be implemented. The integration of ETH 2.0 can potentially enhance transaction speed and facilitate a transition to the same network.

Somay Chopra[3] has introduced a key innovation in the system that is the use of credit based payments, which are handled through smart contracts on the Ethereum blockchain. Under this system, drivers and passengers are assigned credit scores based on their past behavior and feedback. Drivers with high credit scores will be more likely to receive ride requests, while passengers with high credit scores will be able to access more drivers and may receive preferential pricing. The major drawbacks are privacy concerns. The use of a credit scoring system may raise privacy concerns for some users, as their behavior and feedback data would be used to calculate their credit scores. The other one is dependency on the Ethereum network. The credit-based ride-sharing system relies on the Ethereum blockchain for its operation.

[4] Involves creating a platform that allows users to offer or request rides from others, while ensuring the security and transparency of the transaction. The DApp is built using Ethereum smart contracts, which are self-executing programs that automatically enforce the terms of the agreement between the riders and drivers. These smart contracts hold the digital currency used for payment, and the transaction is only executed once the terms of the agreement are met. To ensure the security and privacy of the users, the DApp uses encrypted communication channels and secure authentication methods. This prevents unauthorized access to the platform and the user's data. Users may be hesitant to switch from established ride-hailing platforms to a new, untested block chain-based system.

In [5], Atharv Hankare outlines how ridesharing aims to maximize gasoline usage efficiency by allowing others to travel the same route in shared rides.

However, current transportation options rely on a centralized authority, making them vulnerable to errors and privacy concerns from both internal and external attackers.

These systems are also susceptible to outside threats and fraud, with expensive payment processing by ride-sharing service providers. To address these issues, this study proposes the Ether Rider system, based on Ethereum blockchain technology. Ether Rider allows drivers to offer decentralized transportation services, where both drivers and passengers can protect their trip information, including pick-up and drop-off locations, arrival and departure times, and secure payment using the Ethereum blockchain. By leveraging the distributed ledger, drivers and rider scan create a more user-driven, value- oriented market place

In their paper [6], Luis Angel D. Bathen proposed RiderS, a decentralized self-driving ride-sharing ecosystem with a focus on privacy. The system aims to enable autonomous vehicles to participate in the ride-sharing economy through a self-sovereign biometric solution that uses computer vision for individual registration and authentication while prioritizing privacy. The design also features a decentralized approach to support a self- sustaining ride-sharing economy, incorporating a proof-of- matching geo-aware consensus technique for validating and rewarding self-driving cars. The system relies on each vehicle's internal processing power for transaction authentication and ecosystem maintenance while earning rewards. Test results demonstrate the biometric solution's high matching rates and accuracy, along with privacy concerns. The study concludes that RiderS offers a cutting-edge solution for decentralized, self- driving ride-sharing that prioritizes privacy.

In his paper [7], Ryan Shivers develops a framework for building a certainly shielded decentralized ride-hailing system where blockchain platform called Hyperledger fabric that is being used to implement the architecture. By using a static analysis tool and effectively known security models for assessing the implementation, as well as by tracking effectiveness under an abundance of network congestion. Each organization involved can develop its own client application and share the riders load. An enhancement could have been that by incorporating Hyperledger Fabric, the framework would offer an extra layer of transparency and decentralization, making it even more secure.

In their paper [8], Namasudra proposes a decentralized cab-sharing system that utilizes blockchain technology, eliminating the need for a trusted third-party. The system ensures safety and security by incorporating a reputation system that evaluates and

ranks riders and drivers based on their past behavior and travel patterns. Users can make informed decisions when selecting participants for rides based on their reputation scores. However, a potential concern is the risk of centralization, where highly ranked users may gain excessive power within the platform. Careful consideration is necessary to prevent such imbalances and maintain a fair and inclusive environment for all users.

The paper[9] proposes a decentralized ride-hailing system that overcomes the limitations of traditional centralized platforms. It utilizes block chain and IPFS technologies to ensure transparency, security, and privacy. Through block chain, a distributed ledger is created to securely store ride data, user information, and transactions, reducing reliance on a central authority. IPFS integration provides decentralized and robust storage, guaranteeing data redundancy and availability.

Advantages of the proposed system include improved privacy, enhanced trust among participants, and protection against unauthorized access or data manipulation. The paper discusses the technical architecture and implementation mechanisms, showcasing the transformative potential of block chain and IPFS in the ride-hailing industry.

Implementing and maintaining such a system presents technical complexity. Expertise in block chain and IPFS is crucial for infrastructure development, smart contract management, and communication protocols. However, the benefits offered by this decentralized approach have the potential to revolutionize ride-hailing. It addresses limitations and provides a more secure and transparent experience for all participants.

This paper [10] introduces a system called Nereus that aims to provide an anonymous and secure ride-hailing service. The system utilizes private smart contracts to ensure the confidentiality of user information and transaction details. One noteworthy aspect of Nereus is its focus on preserving user anonymity. By employing zero-knowledge proofs and ring signatures, the system conceals the identities of users and drivers while maintaining the integrity of transactions. This enhances privacy and reduces the risk of personal information exposure. The paper also highlights the use of private smart contracts, which enable secure and verifiable execution of ride-related operations without disclosing sensitive data.

Implementing and verifying zero-knowledge proofs can be computationally intensive and resource-consuming. Generating and validating proofs often require complex cryptographic computations, which can impact the performance and scalability of the system.

[11] Introduces a block chain-powered ride-sharing system that focuses on accurate matching of riders and drivers while ensuring privacy preservation. One key aspect of the system is the accurate matching algorithm, which aims to optimize the process of pairing riders with suitable drivers based on various criteria such as location, availability, and user preferences. This algorithm helps improve the efficiency and effectiveness of the ride-sharing service. It discusses techniques to protect sensitive user information and maintain privacy throughout the system's operations.

The paper does not discuss the potential barriers or strategies for achieving widespread adoption of the proposed system. It also does not delve into the specific regulatory challenges or discuss how the proposed system aligns with legal requirements.

The paper [12] presents a ride-sharing system called B-Ride that aims to provide privacy preservation, trust, and fair payment using a public block chain. One of the key contributions of the paper is the integration of privacy preservation mechanisms within the ride-sharing system. B- Ride utilizes techniques such as pseudonymous identities and

encryption to protect the personal information of riders and drivers, enhancing privacy and confidentiality. The paper addresses the issue of fair payment by introducing a payment protocol that ensures transparency and accuracy in fare calculations. The use of smart contracts on the public block chain enables automated and verifiable payment settlements, reducing the possibility of fraudulent or unfair transactions. This served as a source of inspiration for our work. Ideas were drawn from the concepts presented in the paper, with a particular focus on privacy preservation, trust establishment, and fair payment mechanisms. Techniques such as pseudonymous identities, encryption, and reputation-based systems were incorporated to enhance privacy, trust among participants, and ensure transparent and accurate payment settlements in our ride-sharing system.

The paper [13] introduces a car-sharing platform that utilizes block chain technology. The authors propose a decentralized system that aims to enhance the efficiency and security of car-sharing services. The main objective of the platform is to enable peer-to-peer car sharing, eliminating the need for intermediaries such as car rental companies. By leveraging block chain, the system ensures transparency and immutability of transaction records, enhancing trust among participants.

Smart contracts are employed to automate the rental process, including vehicle reservation, payment settlement, and access control. One potential drawback is the scalability issue associated with block chain technology. As the number of users and transactions increases, the blockchain may face challenges in terms of transaction processing speed and network congestion. This limitation may impact the real-time usability and user experience of the car-sharing platform.

[14] The paper presents a secure decentralized car-sharing system based on block chain technology .The authors propose a solution that addresses the security and trust issues associated with traditional centralized car-sharing platforms. The system leverages block chain's transparency and immutability to enhance security and trust among participants. Issues could include scalability issues, complexity in implementing and maintaining the block chain infrastructure, or potential vulnerabilities in the smart contracts. Further analysis and evaluation would be necessary to uncover any potential

drawbacks of the system.

Taking inspiration from the decentralized approach presented in [15], the objective is to explore and enhance fair cost- sharing mechanisms in ride-sharing and vehicle-pooling systems. The authors' proposed system addresses the critical challenge of unfair cost allocation that often plagues centralized ride-sharing platforms. By leveraging the insights from this paper, innovative solutions will be developed to promote fairness and equitable distribution of costs among participants in the research.

This paper[16] presents a system that enhances security and trust in ride-sharing through a consortium block chain.

Challenges such as governance, consensus, and scalability need further research for practical implementation in real-world scenarios.

3. APPROACH

The Aim is to provide a completely decentralized Community-based Taxi Booking platform built on Ethereum Blockchain. The platform is easy to use and customers can make payments with Ethereum. The Focus is on giving back their old fashioned independent taxi service along with the touch of the latest technology. Our app has two UIs, one for each rider and driver. Riders create rider requests by providing some spatial data along with temporal constraints, and based on some optimal metric and algorithms which calculate that, the request is routed to some Drivers who have the option to accept or reject the request until the temporal constraints are satisfied.

A user can use a wallet manager such as the MetaMask installed in their browser and visit the webapp, once a wallet is connected to the application the user can either choose to use the app to book cab rides or work as a driver and the "is Driver" flag is set to true or false accordingly.

Fig2 shows the rider UI and Fig3 shows the driver UI.

The details of the previous rides are also shown in the history section of the app. The rider can then create a ride request by providing details like the current location and final destination and the fare is calculated as per the distance using the Algorithm 4.1 as shown in Fig 4. The calculated fare once approved by the rider is confirmed and gets added to the "ride Requests" collection. Any driver who is active on the web app searches for the most suitable ride.

The driver's current location is taken and the most suitable ride request is selected among the currently active "ride Request" collection. The collection is updated prior to making the selection to purge ridere quests which are older than one hour, then the ride whose source is closest to the driver is returned. Once the driver receives the most suitable ride, he can either accept or reject the request as depicted in Fig 5.

If the driver accepts the ride request, all the rider details, driver details and the ride details are clubbed together and sent for storage. The ride details are then checked in the "finalized Rides" mapping and if the ride request is already confirmed by some other driver, the rider confirmation failed message is shown to the driver. If the rider eques tdetails are not found in the "finalized Rides" mapping, the ride details are stored in the "finalizedRides" mapping, and the status is set to "ongoing".

The ongoing ride details are then sent to the "ongoing Rides" collection with the "ride Completed_confirmation_rider" and "rideCompleted_confirmation_driver" flag set to false. Once the ride is completed in the real world, both the rider and the driver confirms the rideas completed on the app and the "ride Completed_confirmation_rider" and "ride Completed_confirmation_driver" flags are set to true. The ride details are then removed from the "ongoing Rides" collection and moved to the "past Rides" collection.

Once the ride completion confirmation is sent, the ride status in the "finalized Rides" mapping is changed from "ongoing" to "complete". Transfer of the ride amount then done from the rider to the driver. Here the GAS fee for the block chain transaction Is borne by the rider. Once the transaction is completed successfully, the confirmation notification is shown in the user's crypto wallet which is usually MetaMask.

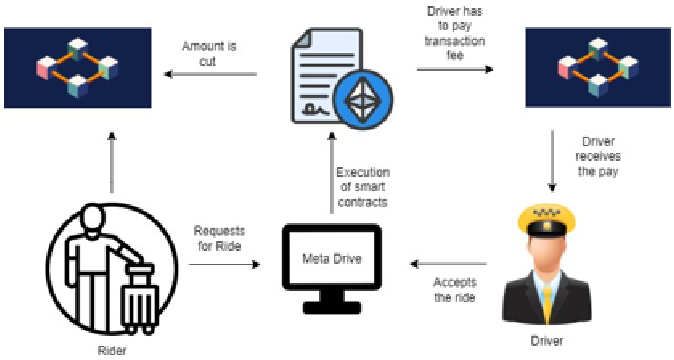

Fig1: High level design of the system

Fig1 is the high-level design over view of the decentralized web app consisting of an end user, a frontend and the Ethereum blockchain and the smart contracts with data storage.

In mongo DB, there are two structures defined:

1. Ongoing Ride Schema: The ongoing ride schema represents the information related to an ongoing ride between a rider and a driver.
2. Ride Request Schema: The ride request schema represents the information about a rider's request for a ride.

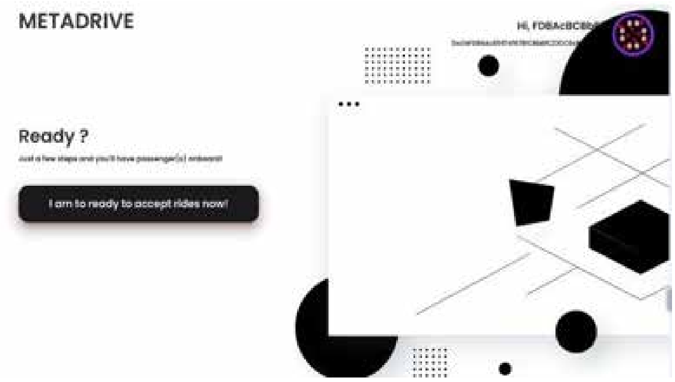

Fig2: Driver SideUI

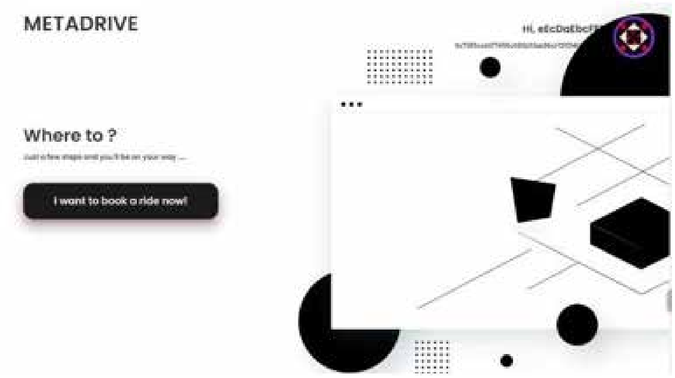

Fig3: Rider SideUI

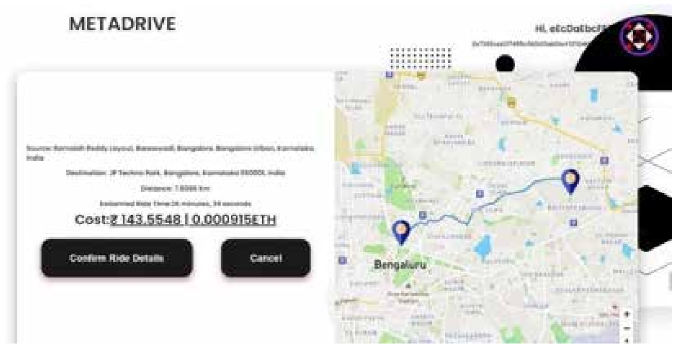

Fig4: Rider confirmation page

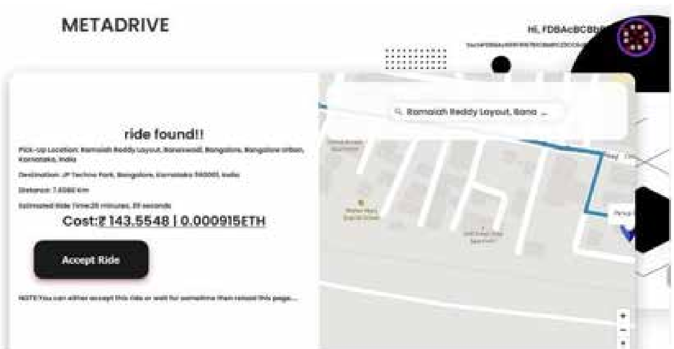

Fig5: Driver confirmation page

Leveraging the power of smart contracts, the proposed solution automates and enforces contractual terms, eliminating the need for intermediaries and reducing costs while ensuring trust and efficiency in the execution of business processes.

The contract defines three emain structs:

1. Coordinate: Stores latitude and longitude evalues a suint256.
2. User: Stores user details such as the user's Ethereum address, rating, driver status, driving license number, and the number of rides the user has taken.
3. Ride: Represents a ride, including details such as the rideID (MongoDB hash), rider ID, driver ID, source and destination addresses (both as strings and coordinates), distance in meters, and cost.

The contract emits two events:

1. user Created: Fired when a new user is added to the contract, providing user-related information.
2. Ride Finalized: Fired when a ride is completed and finalized, providing information about the ride.

The contract uses two mappings to stored at a:

1. users: Maps Ethereum addresses to user structs, allowing users to be retrieved by their addresses.
2. finalized Rides: Maps ride IDs (MongoDB hash) to ride structs, allowing ride details to be accessed using the rideID.

The contract provides several functions:

1. add User: Allows a user to be added to the contract by providing their driver status and driving license number. The function requires valid inputs and creates a new user struct, storing it in the users mapping. It also emits the user Created event.
2. get User: Retrieves the details of the user calling the function. It returns the user's Ethereum address, rating, driver status, driving license number, and the number of rides taken.
3. check User: Checks if the caller's Ethereum address is associated with a user in the users mapping.
4. Finish Transaction: Used to complete a ride transaction. The driver's address is provided as a parameter, and the contract transfers the specified amount of Ether (msg. value) to the driver's address.
5. Get Calculated Cost: Calculates the cost of a ride based on the provided distance. The function follows a standard taxi pricing model defined by the government of Andhra Pradesh, India. It returns the calculated cost in INR (Indian Rupees)based on the distance.

Overall, the contract allows users to be added to the system, retrieves user details, checks if a user exists, and facilitates the completion of ride transactions by transferring funds to the driver. It also provides a function to calculate the cost of a ride based on the distance traveled, following a predefined pricing model.

4. IMPLEMENTATION

Algorithm4.1isusedtocalculatetheoptimalriderequest to be sent to a Driver when he becomes available for accepting a ride request. The main idea behind the algorithm is to calculate the shortest distance between the driver's current location (Latdriver, Longdriver) and the pickup location of the ride

request (Latpickup, Longpickup) along the curvature of the Earth using a simple algorithm.

Algorithm4.1: Finding optimalRide Request for the Driver Input:

1. Input:
   - Coordinates of the pickup point(Latpickup, Longpickup)
   - Current location of the driver, (Latdriver, Longdriver)
2. Output: Distance between the two points along the curvature of the earth 1Radiusofthe earth in km:
3. R=6371;2
4. Convert the difference b/w latitudes and longitudes to Radian: dLat=(Latpickup-Latdriver)*(PI/180);dLon=(Longpickup-Longdriver)*(P I/180);
5. Calculate the value of as follows: a=sin(dLat/2)*sin(dLat/2)+cos((lat1)*(PI/180))*cos((lat2)*(PI/180))*sin(dLon/2) *sin(dLon/2); 4
6. Calculate the value of distance using the value a obtained in the previous step: c=2*Math.atan2(Math.sqrt(a),M'ath.sqrt(1-a));5 distance = R * c;

The optimal Ride Request for the Driver is the ride with the shortest distance calculated above. That is done by running the above algorithm over each active ride request and returning the ride with the smallest calculated distance.

Algorithm 4.2: Finding optimal Ride Fare

1. Input:
   a. Distance Parameter in meter
   b. Resolution that helps remove decimal from [Lat, Long] values
2. Output: Estimated costing INR
3. Value = (75 * Resolution); if (distance>4*Resolution) value= value+(distance−4*Resolution)*18 return value

This is used for calculating the ride fare based on the distance. It calculates the optimized regulated cost in terms of INR for each Ride Requested by the customer. This is as per the mandatory requirements for cost calculation by the Government of Andhra Pradesh.

5. EXPERIMENTSANDRESULTS

Decentralized Autonomous Systems are the systems of the future, as in comparison to systems that take private info, manipulate transactions between different types of users, use it for targeted advertising, decentralized solutions are better in every aspect be it transparency or their ability to become completely autonomous.

Function	Gas Fee/Transaction (ETH)	INR/ Transaction
Contact Creation/ Deployment	0.0005516	77.81
Initialize	0.0000403	12.74
Fund Ride	0.00003013	4.25
Release Funds	0.00004187	5.91

Table1: Gas fee table for each transaction

The experimental results demonstrate that the use of block chain-based METADRIVE leads to reduced costs compared to traditional platforms. Unlike services like Ola and Uber that implement dynamic cost changes during peak hours, the cost remains constant in the proposed system. This finding highlights the potential for a more stable and predictable cost structure, offering a distinct advantage for users in terms of affordability and transparency.

The experiment included three separate graphs representing different time periods: morning (8am-10am), afternoon (1pm-3pm), and night (6pm-10pm). In these graphs, it was observed that the block chain-based ride-sharing platform, Meta drive, maintained a constant rate throughout all hours. On the other hand, platforms like Ola and Uber exhibited higher fares due to commissions charged by the platform and the implementation of a dynamic algorithm that increases fares during periods of high demand as seen in Fig 6 and Fig 8. The costs were stagnant and close during normal afternoon hours. This contrast in pricing strategies highlights the potential cost benefits of utilizing a block chain-based peer-to-peer ride-sharing system, as it offers consistent pricing without the additional fees and dynamic fare adjustments associated with traditional platforms.

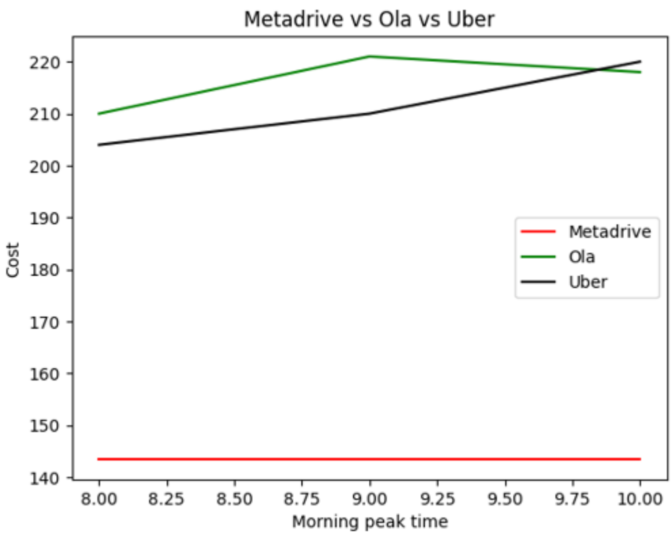

Fig 6: Cost comparison during morning peak hours

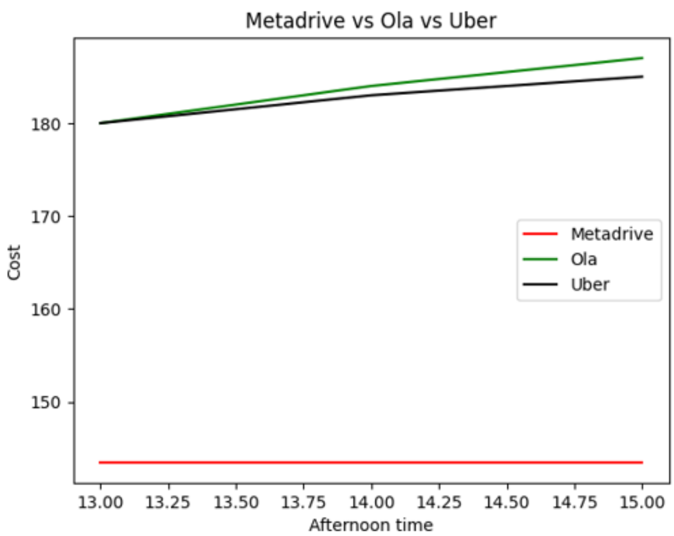

Fig 7: Cost comparison during normal hours

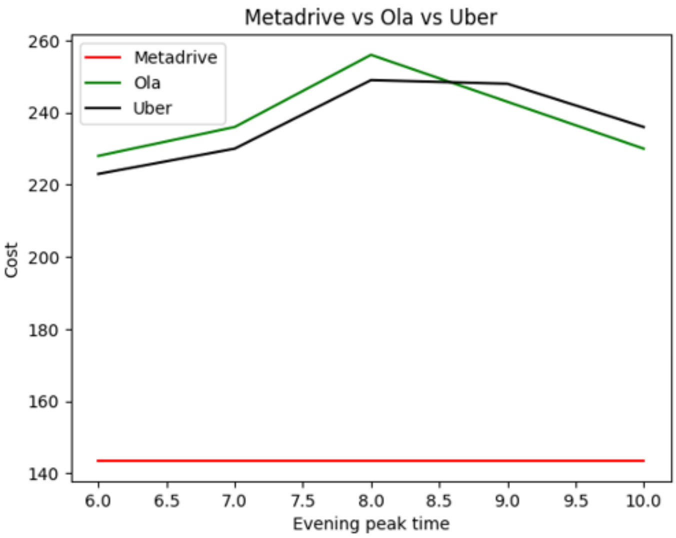

Fig 8:Cost comparison during evening peak hours

In conclusion, the experimental results comparing the proposed system, Meta drive, with traditional platforms like Ola and Uber demonstrate several significant findings. Meta drive's constant rate throughout any time period offers a distinct advantage over the dynamic fare adjustments and commission-based traditional pricing models. The cost reduction observed indicates the potential for more affordable and transparent ride- sharing services. By utilizing encryption techniques and distributing data across multiple nodes on the block chain, it ensures that sensitive user information remains secure and inaccessible to unauthorized parties.

6. CONCLUSION

The systems of the future are decentralized autonomous systems because they are more transparent and have the capacity to become fully autonomous than systems that collect personal data, utilize it for targeted advertising, and interfere with transactions between different categories of users.

However, this technology still needs a few improvements before it can truly revolutionize the tech sector. Decentralized apps and systems exist to give people with services they can use without having to put their trust in anyone, and for this revolution to succeed, people must be educated enough to see this.

In the future, the activation of actual etheruse and deployment of the contract to the Ethereum mainnet is envisioned. The inclusion of a feature to support cloud bill auto-pay, achieved by adding a modest, dynamically computed percentage to each transaction, aligns with the goal of creating a decentralized autonomous system that operates independently without the need for maintenance. Orchestration tools like Kubernetes will be utilized to support auto-scale up and load balancing.

Furthermore, the consideration of using a private block chain solution like Hyperledger, instead of a public block chain like Ethereum, is aimed at addressing privacy-related concerns in the existing system design.

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